PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : A61C 9/00

A1

(11) International Publication Number: WO 92/03985

(43) International Publication Date: 19 March 1992 (19.03.92)

(21) International Application Number: PCT/US91/06459

(22) International Filing Date: 5 September 1991 (05.09.91)

(30) Priority data:
579,300 7 September 1990 (07.09.90) US

(71) Applicant: HONSTEIN, Jerry, P. [US/US]; 6543 Circulo Dali, Anaheim Hills, CA 92807 (US).

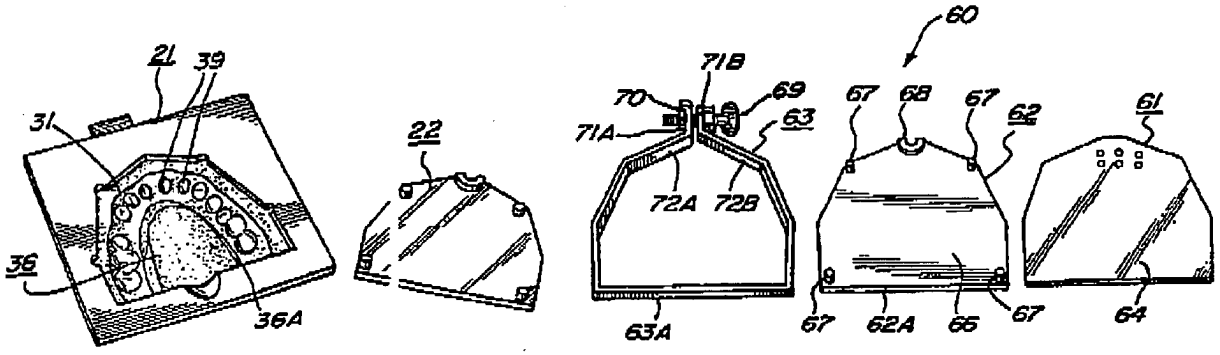
(72) Inventors: SIRAGUSA, Anthony, B. ; 988 S. Ridgecrest Circle, Anaheim Hills, CA 92808 (US). BARNES, Richard, J. ; 23681 Brasilia, Mission Viejo, CA 92691 (US). BARAJAS, Victor, M. ; 5264 North Yvonne Avenue, San Gabriel, CA 91776 (US).

(74) Agent: CHAPIN, William, L.; 8732 Squires Circle, Huntington Beach, CA 92646 (US).

(81) Designated States: AT (European patent), AU, BE (European patent), CA, CH (European patent), DE, DE (Utility model), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).

Published
With international search report.

(54) Title: DENTAL MODELING METHOD AND APPARATUS USING APERTURED MATRIX PLATE



(57) Abstract

A method and apparatus for forming precisely-positioned holes in the base of cast dental models includes a matrix plate (21) having a polygonal aperture (31) adapted to congruently receive a transparent base plate (22), and marks made on the base plate where dowel pins are desired to engage castings of selected parts (39) of the dental impression. The base plate (22) is then removed from the matrix plate, and holes formed therein at the marked locations. A modification (60) useable with non-transparent base plates (62) employs a transparent transfer plate (61) having the same outline shape as the base plate which is inserted into the matrix plate and marked. The transfer plate (61) is then removed, clamped to a base plate (62) with a clamp (63), and holes formed in the base plate at locations indicated by marks on the transfer plate.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland			SN	Senegal
CI	Côte d'Ivoire	KR	Republic of Korea	SU+	Soviet Union
CM	Cameroon	LI	Liechtenstein	TD	Chad
CS	Czechoslovakia	LK	Sri Lanka	TG	Togo
DE*	Germany	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		

+ **Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.**

WO 92/03985

DENTAL MODELING METHOD AND APPARATUS USING APERTURED MATRIX PLATE

Background of the Invention

A. Field of the Invention

The present invention relates to methods and apparatus for making dental models. More particularly, the invention relates to an improved method and apparatus for producing crowns, bridges tooth prostheses and other dental restorations.

B. Description of Background Art

Dental models are widely utilized in the fabrication of replacements, or restorations, for missing or damaged teeth. Such models are usually produced in a sequence of well-known steps. First, a negative impression is made by a dentist of the upper or lower jaw of a patient, using a flexible, quick-setting resilient molding material, such as liquid latex rubber poured into a holding device. After the rubber has set, the negative impression and holding device are removed from the patient's mouth and positioned so that the openings of the negative impression face upwards. Thus, an upper jaw impression is removed from the mouth retained in the same orientation, while a lower jaw impression is inverted after removing it from the patient's mouth. A jaw impression in a holder is then filled with a liquid plaster material, which is frequently referred to as die stone. After the die stone has hardened, the casting is removed from the flexible dental impression mold.

The casting, or model as it is usually referred to, is a positive replication of that portion of the jaw initially used to make the negative impression mold. Thus, the model is an accurate replica of the teeth and soft tissue of the upper or lower jaw, or a portion thereof, from which a negative impression has been made.

Dental models made as described above usually have an arched shape and are therefore, frequently referred to as dental arches. Such dental arches are usually fastened to some sort of base plate for convenience in performing further steps described below.

The existing art utilizes several techniques of providing a base plate for dental arches. The techniques fall generally into either of two broad method classifications. One method utilizes a base of the gypsum-like die stone that is used to make the arch, and is formed from liquid die stone, after the dental arch is formed, by pouring the liquid die stone into a box form positioned around the outer perimeter of the already hardened dental arch.

The other method of providing a base for a dental arch consists of attaching the arch to a pre-manufactured plate made of dimensionally stable material and having a generally semi-circular shape, the convex surface of which conforms generally to the convex surface of the dental arch.

Bases are provided for dental arches so that the arch may be segmented into individual sections or dies, by means of saw cuts, and removably returned to the original positions of the sections in the arch. Individual sections, or dies, are utilized in the fabrication of dental restorations including dentures, partial dentures, crowns, jackets, bridges, and implant supported restorations. The dies are used as models for making individual restorations of various materials such as gold and other metals, plastics and various ceramic materials. After a restoration has been fabricated, it must be remounted on the arch support base at the precise position that it was removed from, to verify that the restoration is of the precise shape and size to fit properly in the mouth of the patient.

The method of removably attaching individual dies to the arch support base usually consists of molding two dowel pins into each die position of the dental arch, the dowel pins

protruding downwards into corresponding holes in the base. Two dowel pins are used to preclude rotation of a die with respect to the base.

Several methods exist for locating dowel pins in desired positions, typically two per tooth, in each die. The accuracy of placement of pins in each die is critical, since even a small placement error could result in the wall of a die breaking through if a saw cut is too close to a pin. Therefore, the preferred method of molding pins into a dental arch and fitting the pins into a base employs a pre-manufactured, pre-fabricated base made of plastic material having greater dimensional stability than the die stone from which the arch is fabricated.

Several systems exist for pouring a dental model utilizing a pre-fabricated, as opposed to a poured, integral base.

One such system, disclosed in Zeiser, U.S. Patent No. 4,371,339, Denture Mold And Method Of And Arrangement For Its Manufacture, requires the use of a relatively complicated, heavy and expensive orienting apparatus, manufactured to precise tolerances, for holding a dental impression while determining the locations on a pre-fabricated base plate where holes are subsequently to be made for securing dowel pins which will be molded into a dental arch.

Another method and apparatus for making dental models using pre-fabricated base plates is disclosed in Kiefer, U.S. Patent No. 4,708,835, November 24, 1987, Method And Apparatus For Making A Dental Model Mounted On A Base Plate. In Kiefer, a pre-fabricated base plate containing a plurality of pre-formed holes is fitted with dowel pins in each location where it is desired to make a die removable from the cast dental arch. Two methods of determining which of the pre-formed holes in a base plate are to have dowel pins inserted in them are disclosed. Both methods

require that a dental impression be attached to a carrier plate having guide means for removably receiving a base plate in a precisely repeatable orientation with respect to the dental impression. The carrier plate includes a flat base and a vertical wall or upright which protrudes upwards from the rear edge of the base.

One version of the Kiefer method requires the use of a transparent datum plate which is positioned over the base plate and fitted with marker pins at desired locations. The datum plate is then removed from the carrier plate, flipped over and re-mounted on the opposite side of the upright of the carrier plate. A base plate is then mounted to the upright of the carrier plate, over the datum plate, and dowel pins inserted into pre-formed holes in the base plate at those positions occupied by marker pins in the underlying datum plate. Both datum plate, and base plate with dowel pins inserted are then removed from the carrier plate, and the base plate flipped over and remounted to the opposite side of the carrier plate upright, over a dental impression containing freshly poured liquid die stone, and pushed downwards so that the base plate contacts the impression. The dowel pins thus protrude into the liquid die stone, and are thereby secured in the cast dental arch when the die stone hardens.

In a second version disclosed in Kiefer, a transparent base plate having pre-formed blind holes on one side, and depressions on the opposite side of the plate aligned with the holes, for receiving colored marking ink, is placed over a dental impression. Those depressions are locations where dowel pins are desired are then marked with ink, and dowel pins inserted in the corresponding blind holes.

All of the prior art methods for locating dowel pins in a cast dental arch, including those disclosed in Zeiser and Kiefer, require the determination of dowel pin locations to be made with impressions fixed and stabilized in position relative to reference points on a specially designed

impression mounting or carrier plate. Prior art systems also require that a fixed relationship exist between the base plate and mounting plate. This requirement demands elaborate procedures for stabilizing, "boxing," i.e., providing an enclosure for holding liquid die stone and supporting a base plate in an established relationship to the impression. Also, all undercut areas of the negative dental impression, which has a irregular shape that varies in size from one patient to another, must be "blocked out" or trimmed away from the impression. This is to prevent liquid die stone from being trapped in irregular regions of the impression, which would hinder removal of a cast dental arch from the impression.

The present invention was conceived of to provide an improved method and apparatus for producing dental models that overcome certain limitations of prior art systems.

Objects of the Invention

An object of the present invention is to provide an improved method and apparatus for producing dental models which utilizes materials and/or apparatus which are inherently lower in cost than prior methods and apparatus.

Another object of the invention is to provide a method and apparatus for making dental models which eliminates the requirement for a relatively heavy carrier plate, thus reducing mass to be vibrated during solidification of die stone in a dental impression.

Another object of the invention is to provide a method and apparatus for making dental models which affords greater ease of use than prior art methods.

Various other objects and advantages of the present invention, and its most novel features, will become apparent to those skilled in the art by perusing the accompanying specifications, drawings and claims.

It is to be understood that although the invention disclosed herein is fully capable of achieving the objects and providing the advantages described, the characteristics of the invention described herein are merely illustrative of the preferred embodiment. Accordingly, we do not intend that the scope of our exclusive rights and privileges in the invention be limited to details of the embodiments described. We do intend that equivalents, adaptations and modifications of the invention reasonably inferable from the description contained herein be included within the scope of the invention as defined by the appended claims.

Summary of the Invention

Briefly stated, the present invention comprehends an improved method and apparatus for producing dental models of the type used in the fabrication of dentures, partial dentures, crowns, jackets, bridges and implant supported restorations, all of which may employ metals, plastics and/or ceramic materials. The improved method and apparatus according to the present invention employs a pre-fabricated base plate of generally uniform thickness and a polygonal outline. A positioning matrix comprising a flat rigid plate with a polygonal perforation or aperture through its thickness dimension is also part of the present invention. The perimetric walls surrounding the aperture are adapted to fit tightly around the perimeter of the base plate, which is removably insertable into the positioning matrix.

The dental modeling method according to the present invention includes placing the upper, trimmed peripheral border of a negative dental impression in contact with the lower flat side of the positioning matrix plate, and forming a liquid-tight seal between the upper perimeter of the impression and lower surface of the plate. The seal is simply and conveniently formed by first kneading a small quantity of silicone putty or similar resilient sealing material into a rope-like shape, and then using the rope to form a bead joining the upper peripheral border of the

impression to the lower surface of the positioning matrix plate, the bead encircling the perimeter of the aperture through the plate.

A relatively thin transfer plate made of a dimensionally stable material and having a polygonal outline substantially identical in size and shape to that of the base plate and to that of the aperture through the positioning matrix plate is then inserted into the aperture, in overlying contact with the upper surface of the dental impression. A marking pen or pencil is then used to mark on the upper surface of the transparent transfer plate those locations where it is desired to provide dowel pins in the base plate for supporting removable sections, or dies in a cast dental model or arch. The marked transfer plate is then removed from the positioning matrix plate, and placed in overlying conformal contact with a base plate. A clamp which conforms to the perimeters of the base plate and transfer plate is then placed around the two plates and tightened. Holes are then drilled into the upper surface of the base plate opposite the transfer plate, at each of the locations indicated by the marks on the transfer plate. A drill press of the type having a drill which projects upwards through a work table at a location indicated by an index pointer which projects downwards from a position above the table provides a convenient means for drilling the required holes.

The drilled base plate is then removed from the clamp, and dowel pins inserted into the holes. Next, liquid die stone is poured into the dental impression through the aperture of the positioning matrix plate attached to upper surface of the impression. The base plate is then inserted into the aperture, upper or pin side down, the pins protruding into the liquid die stone, which is then allowed to harden. After the die stone has hardened, the base plate, cast dental arch, and dental impression are pushed en masse down through the aperture in positioning matrix plate. The bead of sealing material is removed from the bottom surface of the positioning matrix plate, either before or

after the previously described step, as desired. Next, the negative dental impression forming the mold for the cast dental arch is separated from the dental arch. The arch is then separated from the base plate to permit sawing the cast arch into individual segments or dies. Each of the dies has two downwardly protruding dowel pins cast into the die, permitting each die to be returned to a precise location on the base plate, by inserting the dowel pins into the appropriate holes in the upper surface of the base plate.

In a variation of the novel method and apparatus according to the present invention, the transparent transfer plate and holding clamp are not used. Instead, a transparent base plate is inserted into the aperture of the positioning matrix plate, marked, and drilled.

Brief Description of the Drawings

Figure 1 is an upper plan view of a novel positioning matrix plate and base plate forming part of the present invention.

Figure 2 is an upper perspective view of a negative dental impression provided with a bead of material as part of the method according to the present invention.

Figure 3 is a lower perspective view showing the positioning matrix plate of Figure 1 attached to the bead and impression of Figure 2.

Figure 4 is an upper perspective view of the assembly of Figure 3, prior to the insertion of a base plate into the matrix positioning plate.

Figure 5 is an upper perspective view of the base plate of Figure 1 inserted into the aperture of the matrix positioning plate of Figure 4, and showing the method of marking desired locations for dowel pins on the base plate.

Figure 6 is an upper perspective view of the marked base plate of Figure 5 being drilled.

Figure 7 is a perspective view of dowel pins being inserted into the holes drilled into the base plate as shown in Figure 6.

Figure 8 is an upper perspective view showing a negative dental impression attached to the matrix positioning plate of Figure 1, showing the impression filled with liquid die stone, and showing a base plate of the type shown in Figure 1 provided with dowel pins, preparatory to inserting the base plate into the aperture of the positioning matrix plate.

Figure 9 is an upper perspective view of the matrix positioning plate and base plate of Figure 8 during the setting or curing of liquid die stone.

Figure 10 is a lower perspective view of the sealing bead being removed from the matrix positioning plate of Figure 9.

Figure 11 is an upper perspective view of the cast dental arch having been removed from the matrix positioning plate of Figure 10.

Figure 12 is a perspective view of the cast dental arch of Figure 11 removed from the negative impression mold, and separated from the base plate.

Figure 13 is an upper perspective view of the cast dental arch of Figure 12 re-attached to the base plate, with certain segments or dies of the arch removed from the base plate.

Figure 14 is an upper perspective view of a base plate, transfer plate and clamp used in an alternate embodiment of the present invention.

Figure 15 is an upper perspective view of the transfer plate and base plate of Figure 14 having been clamped together and being drilled at locations previously marked on the transfer plate in a manner similar to that shown in Figure 5.

Figure 16 is an upper perspective view of components of another version of the apparatus according to the present invention which is particularly useful in the fabrication of quadrant or partial dental models.

Description of the Preferred Embodiments

Referring now to Figures 1 through 16, methods and apparatus for dental modeling using a polygonally apertured positioning matrix plate according to the present invention are depicted.

As shown in Figure 1, one embodiment of the apparatus according to the present invention includes a positioning matrix plate 21 and a base plate 22. Base plate 22 is of generally uniform thickness and is fabricated from a dimensionally stable, transparent material such as acrylic or polycarbonate plastic. Base plate 22 has a generally semicircular shaped outline with a straight chordal base wall 23 and a generally semicircular or arch-shaped wall 24. Semicircular wall 24 is preferably modified from a curvilinear shape to the shape of a polygon circumscribed around the curvilinear arch. Thus, as shown in Figure 1, "semicircular" wall 24 has six generally straight polygonal wall surfaces 25, instead of smooth curvilinear wall surfaces. As will become apparent in the ensuing descriptions, the exact number, size and intersection angles of polygonal wall 25 may be varied as desired. However, the polygonal outline of base plate 22 should not be rotationally symmetric, for reasons which will become apparent from the ensuing description of the invention.

The size and shape of base plate 22 are adapted to

conformally fit over the concave upper surface of a standard full-jaw negative dental impression. Thus, base plate 22 would typically have a base wall length of approximately 2-3/4 inches, while semicircular wall 24 would have a radius of about 1-3/8 inches. Base plate 22 may have any convenient thickness, typically 1/4 inch. As shown in Figure 1, the flat lower wall surface 26 of base plate 22 has a plurality of short, upwardly protruding bosses. At least three bosses are provided; one boss 27 at each of the two base corners of base plate 22, and one boss 28 at the peak of semicircular wall 24. Corner bosses 27 have a generally cylindrical shape. Peak boss 28 has a generally crescent shape and forms a concave notch 29 in the peak 30 of semicircular wall 24. The purpose of bosses 27 and 28 will be explained below.

As shown in Figure 1, the apparatus 10 according to the present invention includes a "positioning matrix plate" 21. Positioning matrix plate 21 is a thin, uniform thickness plate fabricated from a dimensionally stable material. A wide variety of materials are thus suitable for the manufacture of positioning matrix plate 21. Examples of such materials include thermosetting plastics, thermoplastics such as acrylic, or composites such as fiberglass reinforced epoxy sheets of the kind used to manufacture printed circuit boards. The outline shape of positioning matrix plate may be any convenient shape, such as the rectangular shape shown in Figure 1.

Preferably, a concave thumbnail-shaped depression 21B is formed in the upper surface 21A of matrix plate 21, the wider "cuticle" of the depression penetrating base wall 32.

As shown in Figure 1, an aperture 31 is provided through the thickness dimension of positioning matrix plate 21. Aperture 31 is of the proper size and shape to insertably receive, in a relatively tight interference fit, base plate 21. Thus, as shown in Figure 1, aperture 31 has a straight base wall 32 and a plurality of intersecting

polygonal walls 33 forming a symmetrical, arch-like shape. Also, each intersection vertex of adjacent polygonal walls 33 is preferably notched slightly, thereby forming a plurality of semicircular relief holes 34 adjacent to at least some of the vertices of polygonally shaped base plate 22, when the base plate is inserted into aperture 31 of positioning matrix plate 21. The method of using the apparatus of Figure 1 will now be described.

As shown in Figure 2, the first step in practicing the method of the present invention is the attachment of rope-shaped length 35 of silicone putty or similar resilient putty-like sealing material formed into a bead 35A around the upper peripheral border of negative dental impression 36 contained in holder 37 having a handle 38 protruding outwards from the base of the holder. Next, positioning matrix plate 21 is pushed down into sealing contact with bead 35A, as shown in Figure 3. As shown in Figure 3, bead 35A is adjacent to and surrounds the lower opening of aperture 31.

With dental impression 36 secured to matrix positioning plate 21 by bead 35A of silicone rubber, as described above, a transparent base plate 22 is inserted into aperture 31 of the matrix place, as shown in Figures 4 and 5. Base plate 22 is pushed down into aperture 31 of positioning matrix plate 21 sufficiently far for the upper surface 22A of the base plate to contact the upper surface 36A of dental impression 36. Then, as shown in Figure 5, a fine pointed felt tip pen 2 or any other suitable marking means is used to mark on the lower surface 26 of base plate 22 the desired location of each pair of dowel pins for each tooth die, by viewing the impression 39 of each such tooth through the transparent base plate and marking dots on the plate directly above the impression.

After a base plate 22 has been marked to indicate the desired location of all dowel pins on the base plate, the base plate is removed from matrix plate 21. Inserting a

finger tip into depression 21B in the upper surface 21A of the matrix plate facilitates removal of base plate 22. Holes of the proper size to receive dowel pins are then formed in the base plate. A convenient method of forming the dowel pin holes is shown in Figure 6.

As shown in Figure 6, a drill press 40 of the type having an index pointer 41 positioned above a work table 42 and precisely aligned with the point of a drill bit 43 which is extendable upwards through an aperture 44 in the table may conveniently be used to drill dowel pin holes 45 in upper surface 22A of base plate 22. The use of index pointer 41 is not necessary when drilling a transparent base plate, but provides a convenient means for forming holes in non-transparent base plates used in another embodiment of the invention described below.

After holes 45 have been drilled into the upper surface 22A of base plate 22 at each desired dowel pin location, a dowel pin 47 is inserted into each hole 45, as shown in Figure 7.

Referring now to Figure 8, after dowel pins 47 have been inserted into holes 45 in base plate 22, liquid die stone B is poured through aperture 31 of positioning matrix plate 21 into dental impression 36 attached to the lower surface of the positioning matrix plate. Small amounts C of semi-liquid die stone may be adhered to portions of the upper surface 22A of base plate 22, adjacent dowel pins 47, if desired.

Referring now to Figure 9, a base plate 22 with inserted dowel pins 47, prepared as described above and depicted in Figure 8, is inserted into aperture 31 of matrix positioning plate 21 attached to a dental impression 36 holding liquid die stone B. As shown in Figure 9, relief holes 34 at the intersections of walls of the aperture 31 in positioning matrix plate 21 allow globules D of liquid die stone B to be displaced upwards through the relief holes as the base

plate 22 is pushed downwards through the aperture until it seats against the upper surface 36A of dental impression 36. In this position, dowel pins 47 are submerged in liquid die stone B, and become embedded therein when the die stone hardens.

Referring now to Figure 10, after die stone B has hardened, bead 35A of silicone putty is removed from the lower surface of matrix positioning plate 21. Base plate 22, dental impression 36, and cast dental arch 48 are then pushed downwards en masse through aperture 31 in matrix positioning plate 21, as shown in Figure 11.

Referring now to Figures 11 and 12, dental impression 36 is then pried away from cast dental arch 48 and base plate 22. Dental arch 48 may then be easily separated from base plate 22 by tapping or other means, dowel pins 47 being of the proper size and shape to fit snugly, but not too tightly, into holes 45 in the base plate. Then, as shown in Figure 13, dental arch 48 may be segmented by means of saw cuts into individual dies 49. Dies 49 may then be used to fabricate restorations for individual teeth, and returned to precisely repeatable locations in base plate 22 to check the shape and fit of each of the restorations during the fabrication of the restorations.

Figures 14 and 15 illustrate an alternate embodiment of the novel dental modeling method and apparatus according to the present invention.

In embodiment 60 shown in Figures 14 and 15, a base plate 62 substantially identical in size and shape to base plate 22 is used. Base plate 62 is also made of a dimensionally stable material, but need not be transparent.

Embodiment 60 of the apparatus according to the present invention also uses a transfer pate 61. Transfer plate 61 is made of a dimensionally stable material and has a polygonal outline shape substantially identical to that of

base plate 62. However, transfer plate 61 is required to be transparent. Also, transfer plate is preferably thinner than base plate 62, having a thickness of approximately 1/8 inch or less, for example.

Embodiment 60 of the present invention also includes a clamp 63, the structure and function of which are described below.

The method of using the novel embodiment 60 of the dental modeling apparatus according to the present invention has a substantial number of steps in common with those previously described for the basic embodiment 20 of the novel apparatus. Thus, embodiment 60 includes a positioning matrix plate 21, utilized in precisely the same way as depicted in Figures 2 through 5 and described above. However, in embodiment 60, transfer plate 61 rather than base plate 22 is inserted into aperture 31 of positioning matrix plate 21, for the step shown in Figure 5. Here, upper surface 64 of transfer plate 61 is marked with a pen A at those points where it is desired to locate dowel pins. Since transfer plate 61 may be thinner than base plate 22 or base plate 62, upper surface 64 of the transfer plate may be closer to dental impression 36 than upper surface 46 of base plate 22, were the base plate to be used. Closer spacing between the surface to be marked and the dental impression reduces parallax errors, allowing the locations of dowel pin hole drill points to be determined more precisely relative to the underlying dental impression.

After the location of each desired dowel pin hole has been marked on the upper surface of transfer plate 61, as shown in Figure 5, the marked transfer plate is removed from aperture 31 of positioning matrix plate 21. Then, as shown in Figure 14 and 15, transfer plate 61 is placed down on top of bosses 67 and 68 protruding away from the lower wall surface 66 of base plate 62. Transfer plate 61 and base plate 62 are held in a longitudinally aligned, contacting relationship to one another by any convenient means, such as

clamp 63. Clamp 63 comprises a flat metal strip 63A formed into a polygon which conforms to the polygonal wall of base plate 62 and transfer plate 61. The clamp 63 is tightened around the polygonal perimeter of base plate 62 and transfer plate 61 by means of bolt 69 and nut 70. Bolt 69 passes through aligned holes 71A and 71B through opposite lateral ends 72A and 72B, respectively, of strip 63A.

With base plate 62 and transfer plate 61 held together by means of clamp 63, as described above, dowel pin holes 45 are formed in the upper surface 62A of base plate 62 at the locations marked on the upper surface 64 of transfer plate. Thus, as shown in Figure 15, the same type of drill press 40 used to form holes 45 in base plate 22 may be used to form holes 45 in base plate 62. Bosses 67 and 68, which protrude outwards from the lower wall surface 66 of base plate 62, hold the transfer plate 61 spaced above the base plate during the drilling operation, thus preventing holes from being formed in the transfer plate and thereby permitting re-use of the transfer plate.

Figure 16 illustrates a variation of the embodiment 60 of the apparatus shown in Figures 14 and 15. In the variation 90 shown in Figure 16, base plate 92, transfer plate 91 and clamp 93 are shaped like half sections of corresponding elements 62, 61 and 63, respectively. Thus, variation 90 is suitable for making dental models of partial upper or lower jaw sections, sometimes referred to as quadrants, using a matrix plate 101 having a polygonal aperture 131 matching the perimetric outline of base plate 92 and transfer plate 91. If base plate 92 is made of a transparent material, transfer plate 91 and clamp 93 may be dispensed with, and the method depicted in Figures 1 through 5 used to mark the base plate. A strip of neoprene foam or similar resilient material may used intead of silicone putty 35(Fig.2), said strip being secured to impression 36 by a first, concentrically encircling elastic band. The impression and attached foam strip may be secured to matrix plate 21 by additional elastic bands, notches for the latter which may be provided in the outer wall of plate 21.

What is claimed is:

1. A method of fabricating a dental model which is a positive replica of teeth and connected soft tissue from a negative impression mold previously made from said teeth and soft tissue, said method comprising the steps of:

a. sealing the peripheral border of said impression to the lower surface of a thin, flat positioning matrix plate having a polygonal aperture therethrough which substantially encircles the outer convex locus of teeth indentations in said impression,

b. inserting into said polygonal aperture in said positioning matrix plate a thin, transparent base plate having an outer perimetric wall surface which adapts said base plate to fit relatively tightly into said aperture of said matrix plate with a repeatable orientation with respect thereto,

c. marking the lower surface of said base plate, opposite said impression, those locations where it is desired to provide dowel pins in a model to be cast from said impression,

d. withdrawing said base plate from said aperture in said matrix positioning plate,

e. forming in the upper surface of said base plate at said marked locations holes adapted to receive dowel pins,

f. inserting into each of said holes a dowel pin,

g. pouring sufficient liquid die stone through said aperture in said matrix positioning plate to fill said impression,

h. inserting said base plate into said aperture of said matrix plate with said dowel pins protruding into said

liquid die stone,

i. allowing said liquid die stone to harden, and

j. removing said base plate and the cast dental model formed from solidification of said liquid die stone in said dental impression from said impression and said matrix positioning plate.

2. The method of Claim 1 wherein said steps of sealing said impression to said lower surface of said positioning matrix plate comprises forming a rope-like bead of putty around the upper perimeter of said impression, and pressing said bead into contact with both said matrix plate and said impression.

3. The method of Claim 1 wherein the perimetric outline of said base plate conforms in size and shape to the perimetric outline of said impression.

4. A method of fabricating a dental model which is a positive replica of teeth and connected soft tissue from a negative impression mold previously made from said teeth and soft tissue, said method comprising the steps of:

a. sealing the upper surface of said impression to the lower surface of a thin, flat positioning matrix plate having a polygonal aperture therethrough which substantially encircles the outer convex locus of teeth indentations in said impression,

b. inserting into said polygonal aperture in said positioning matrix plate a substantially thin, transparent transfer plate having an outer perimetric wall surface which adapts said transfer plate to fit relatively tightly into said aperture of said matrix plate with a repeatable orientation with respect thereto,

c. marking on the surface of said transfer plate opposite

said impression those locations where it is desired to provide dowel pins in a model to be cast from said impression,

d. withdrawing said transfer plate from said aperture in said matrix positioning plate,

e. placing said marked transfer plate in conformal overlying relationship to a thin base plate having a perimetric outline which substantially conforms to the perimetric outline of said transfer plate, and clamping together in said conformal relationship said transfer plate and said base plate,

f. forming in the upper surface of said base plate of those aligned locations marked on said transfer plate holes adapted to receive dowel pins,

g. removing said transfer plate from said base plate,

h. inserting into each of said holes in said base plate a dowel pin,

i. pouring sufficient liquid die stone through said aperture in said matrix positioning plate to fill said impression,

j. inserting said base plate into said aperture of said matrix plate with said dowel pins protruding into said liquid die stone,

k. allowing said liquid die stone to harden, and

l. removing said base plate and the cast dental model formed from solidification of said liquid die stone in said dental impression from said impression and said matrix positioning plate.

5. The method of Claim 4 wherein said step of sealing

said impression to said lower surface of said positioning matrix plate comprises forming a rope-like bead of putty around the perimeter of said impression, and pressing said bead into contact with both said matrix plate and said impression.

6. The method of Claim 4 wherein the perimetric outline of said base plate conforms in size and shape to the perimetric outline of said impression.

7. The method of Claim 4 wherein said base plate is provided with bosses projecting downwards from the lower surface of said base plate, whereby said transfer plate is held above said base plate during the step of forming holes in said plate, thereby allowing formation of holes in said base plate without forming holes in said transfer plate.

8. An apparatus for fabricating a dental model which is a positive replica of teeth and connected soft tissue from a negative impression mold previously made from said teeth and soft tissue, said apparatus comprising;

a. a positioning matrix, said positioning matrix comprising a thin plate of generally uniform thickness fabricated from a dimensionally stable material, said plate having a polygonal aperture through its thickness dimension, and

b. a base plate of generally uniform thickness fabricated from a dimensionally stable, transparent material, said base plate having a perimetric outline substantially identical in shape to the perimetric outline of said aperture in said matrix plate, and whereby said base plate may be removably inserted, and reinserted in a precisely repeatable location, into said aperture of said matrix plate, whereby a dental impression may be attached to a lower surface of said matrix plate, said base plate inserted into said aperture of said matrix plate in overlying relationship to said impression, and marks made at those locations on said base plate where

dowel pins are desired, said locations being determined in relationship to said impression by viewing said impression through said transparent base plate.

9. The apparatus of Claim 8 wherein said polygonal aperture is further defined as having the approximate shape of a semicircle having a flat chordal wall, the arcuate portion of said semicircle being approximated by a plurality of circumscribed, straight polygonal walls.

10. The apparatus of Claim 8 wherein at least one intersection of adjacent walls of said aperture of said matrix plate has a notch extending through the thickness dimension of said base plate, thereby providing a relief passageway for air and liquid die stone when said base plate is inserted into said aperture of said matrix plate.

11. The apparatus of Claim 8 wherein said base plate is further defined as having a plurality of equal height bosses protruding away from the lower surface of said base plate, thereby holding the base plate a spaced distance above a horizontal surface on which the base plate is placed.

12. An apparatus for fabricating a dental model which is a positive replica of teeth and connected soft tissue from a negative impression mold previously made from said teeth and soft tissue, said apparatus comprising;

a. a positioning matrix plate, said positioning matrix plate comprising a thin plate of generally uniform thickness, fabricated from a dimensionally stable material, said matrix plate having a polygonal aperture through its thickness dimension,

b. a base plate of generally uniform thickness fabricated from a dimensionally stable material, said base plate having a perimetric outline substantially identical in shape to the perimetric outline of said aperture in said matrix plate, whereby said base plate may be removably inserted, and

reinserted in precisely repeatable location into said aperture,

c. a transfer plate of thin generally uniform thickness, said transfer plate being fabricated from a transparent, dimensionally stable material and having a perimetric outline substantially identical in shape to the perimetric outline of said aperture in said matrix plate, whereby said transfer plate may be removably inserted, and reinserted in a precisely repeatable location, into said aperture of said matrix plate, and whereby a dental impression may be attached to a lower surface of said matrix plate, said transfer plate inserted into said aperture of said matrix plate in overlying relationship to said impression, and marks made at those locations on the surface of said transfer plate where dowel pins are desired in said base plate, and

d. clamping means for holding said transfer plate in a longitudinally aligned, overlying relationship over the lower surface of said base plate, whereby holes for dowel pins may be made in those locations in the upper surface of said base plate which are longitudinally aligned with said marks on said transfer plate.

13. The apparatus of Claim 12 wherein said polygonal aperture is further defined as having the approximate shape of a semicircle, having a flat chordal wall, the arcuate portion of said semicircle being approximated by a plurality of circumscribed, straight polygonal walls.

14. The apparatus of Claim 12 wherein at least one intersection of adjacent walls of said aperture of said matrix plate has a notch extending through the thickness dimension of said base plate, thereby providing a relief passageway for air and liquid die stone when said base plate is inserted into said aperture of said matrix plate.

15. The apparatus of Claim 12 wherein said base plate

is further defined as having a plurality of equal height bosses protruding away from the lower surface of said base plate, thereby holding said transfer plate a spaced distance above said base plate when said holes are formed in said base plate.

16. The apparatus of Claim 12 wherein said clamping means comprises a strap conformable around the outer perimetric wall surfaces of said base plate and said transfer plate, and means for tightening said strap around said perimetric walls.

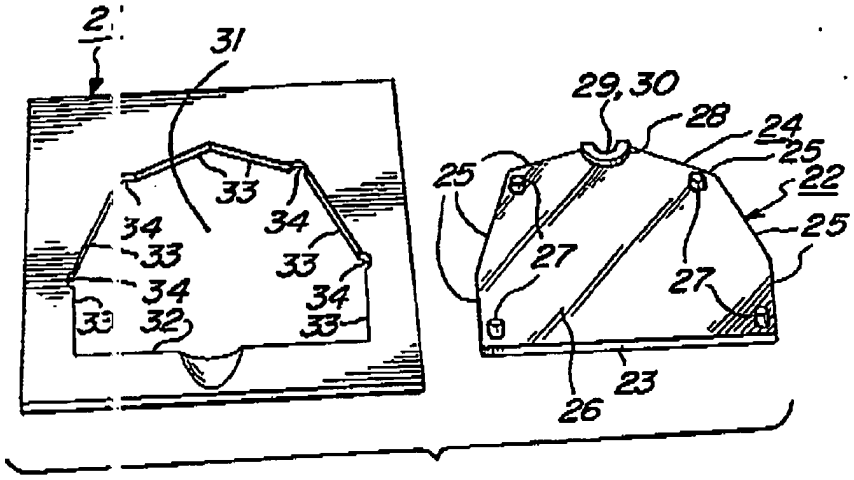


FIG. 1

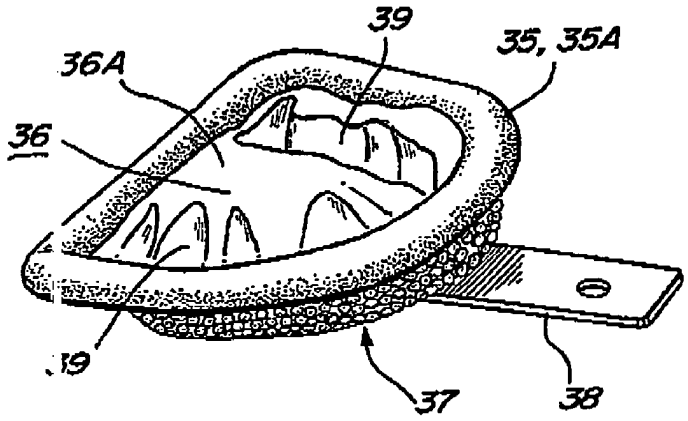


FIG. 2

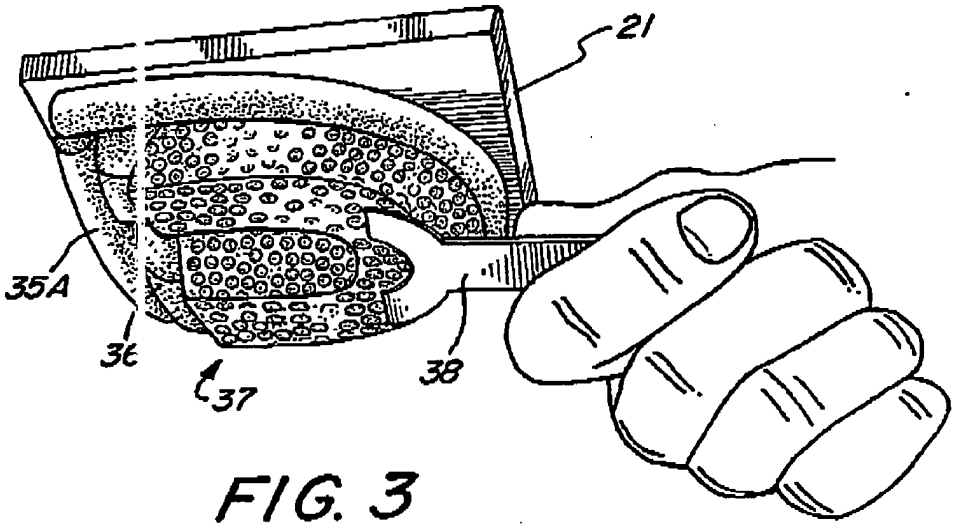


FIG. 3

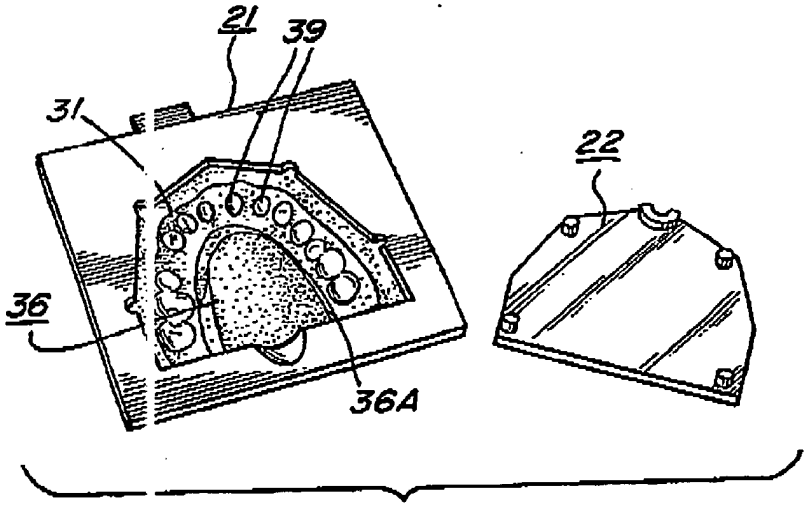


FIG. 4

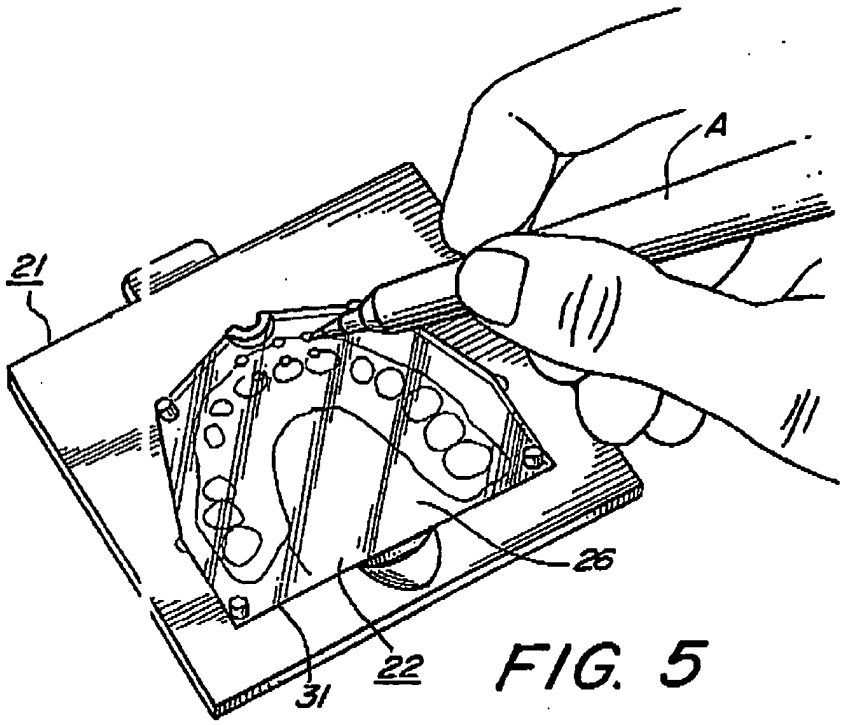


FIG. 5

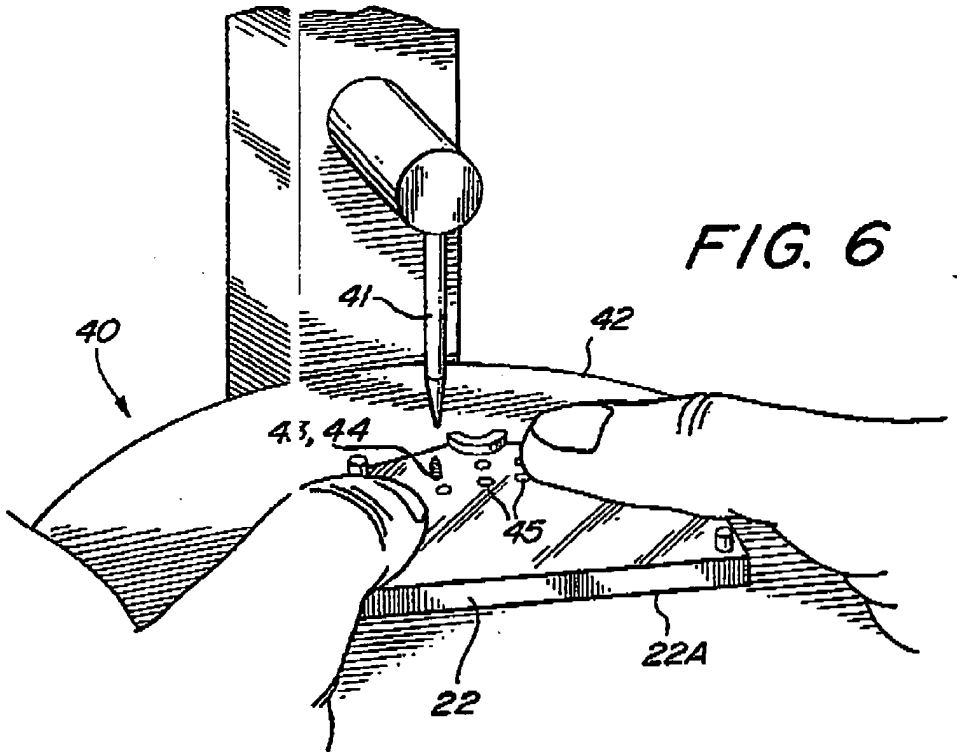


FIG. 6

FIG. 7

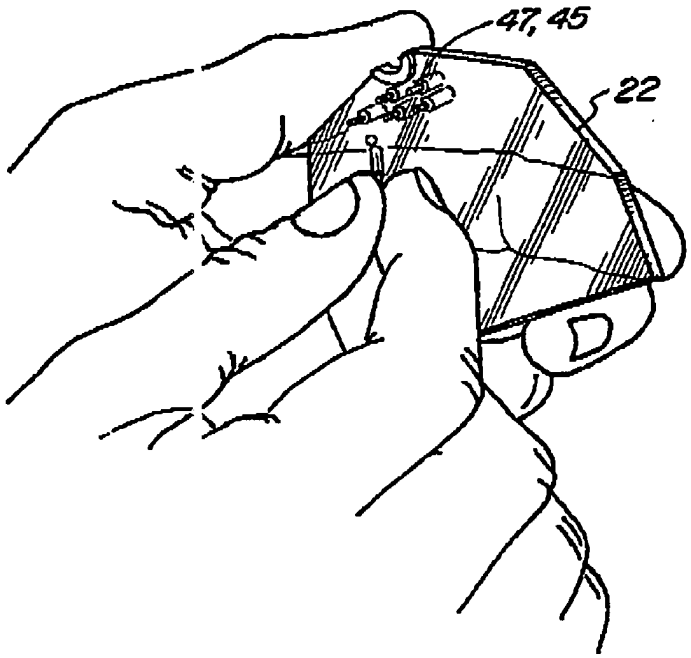


FIG. 8

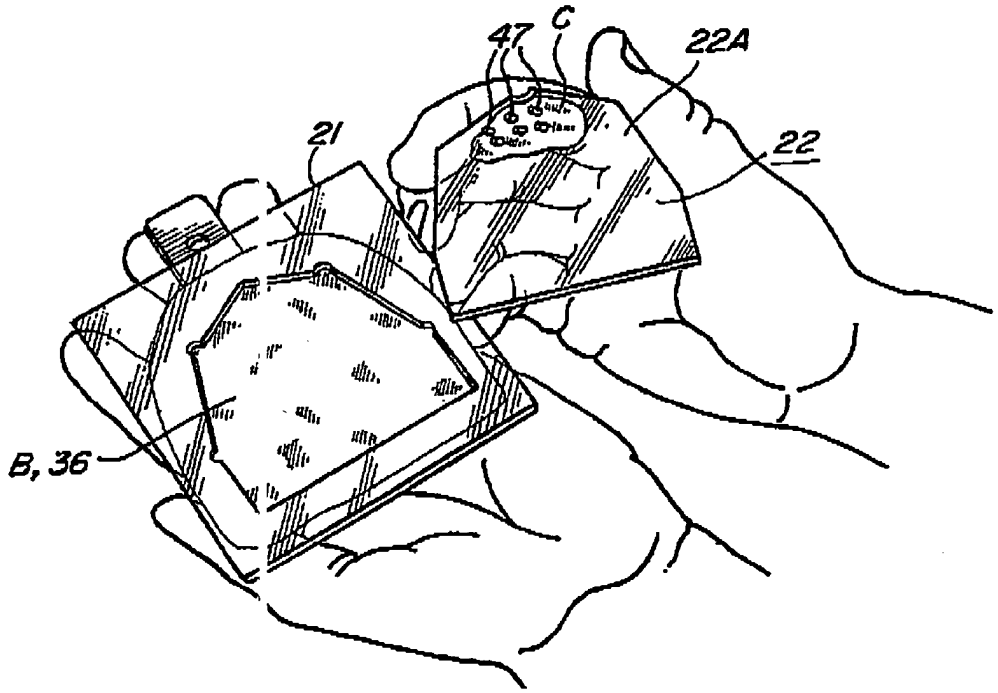


FIG. 9

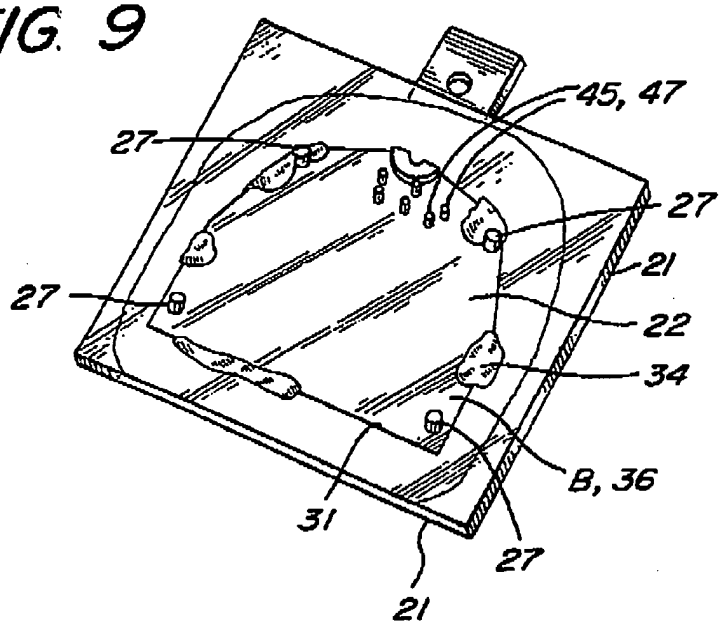
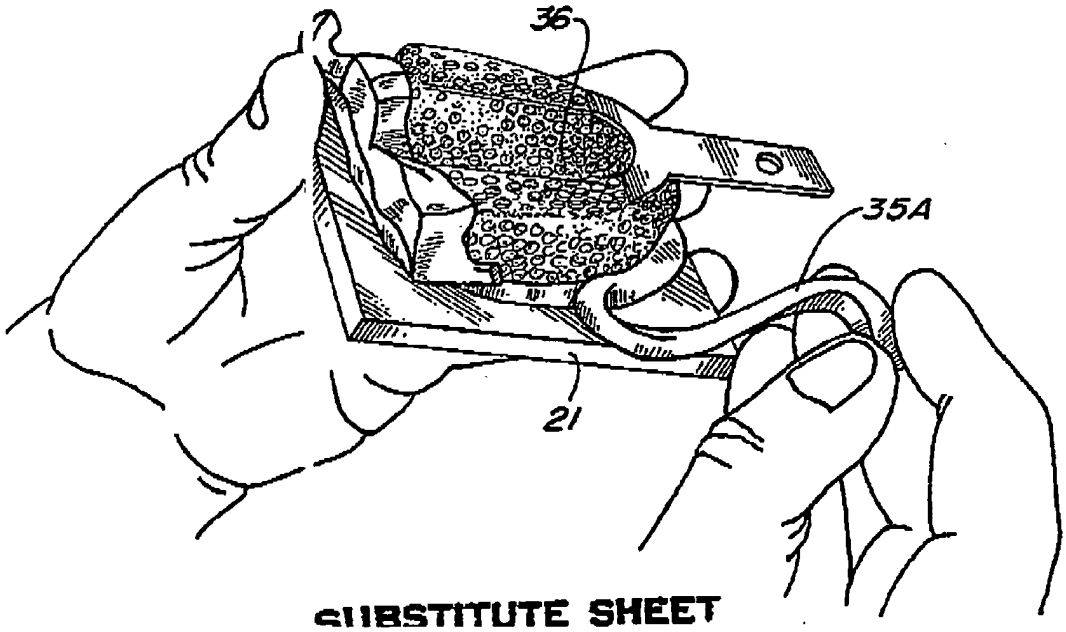


FIG. 10



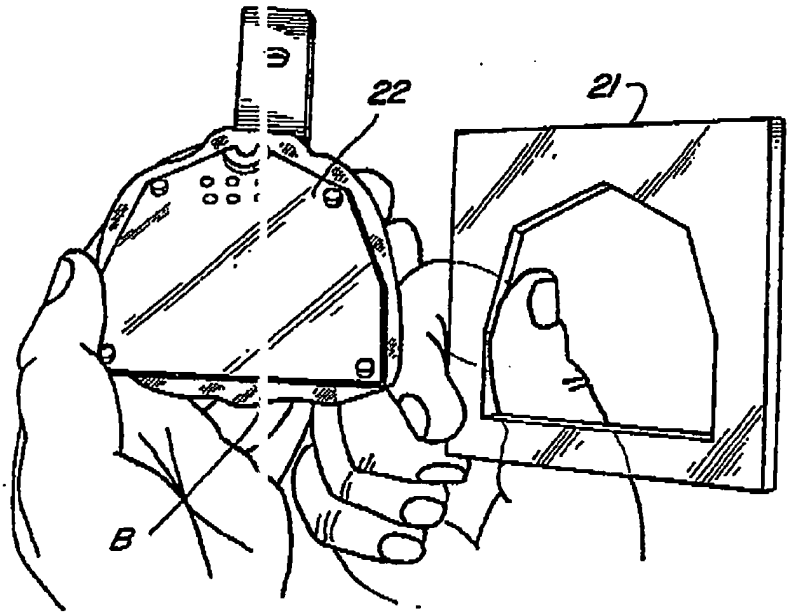


FIG. 11

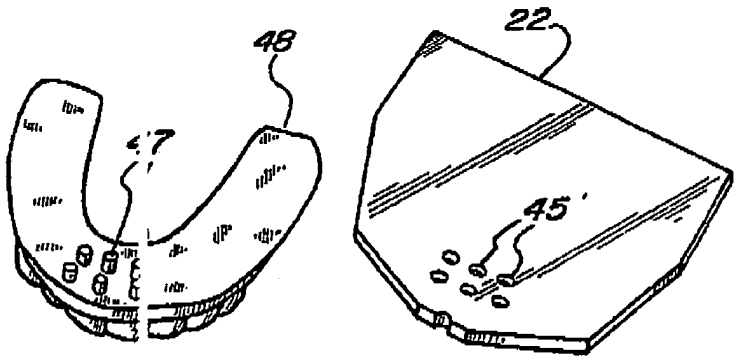


FIG. 12

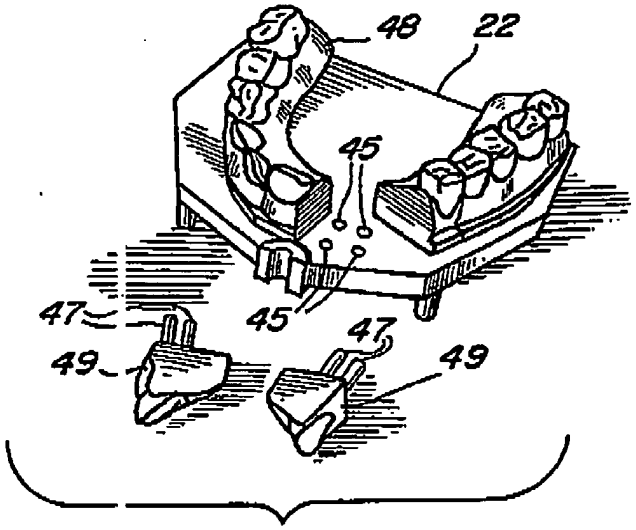

48
22
45
47
45
47
49
49

FIG. 13

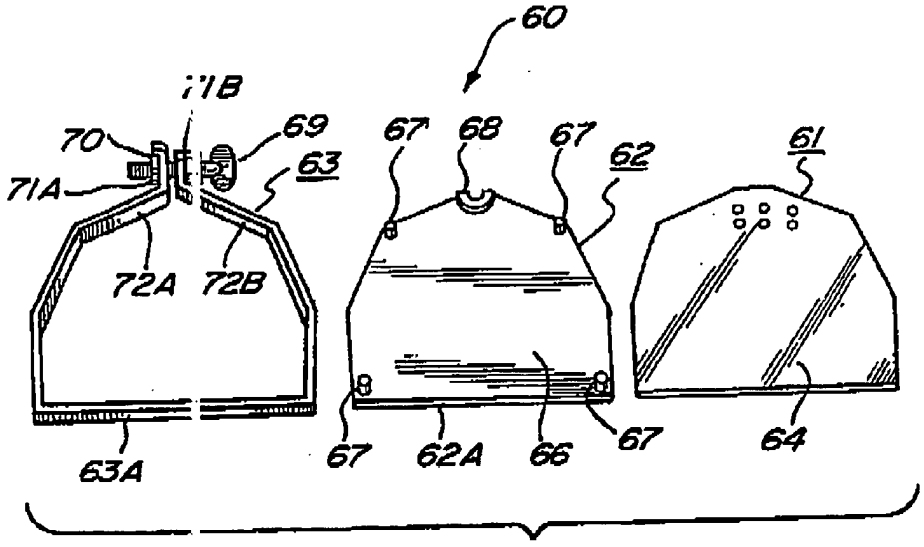

60
71B
70
69
67
68
67
62
61
63
71A
72A
72B
63A
67
62A
66
67
64

FIG. 14

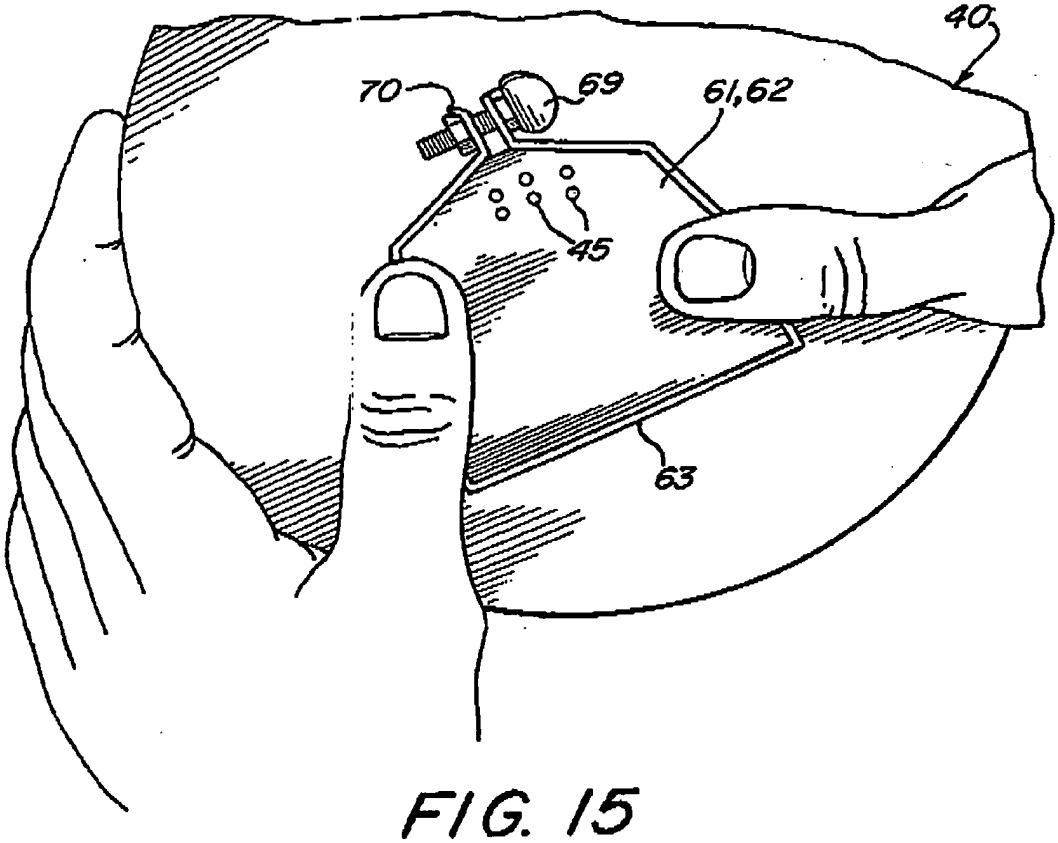


FIG. 15

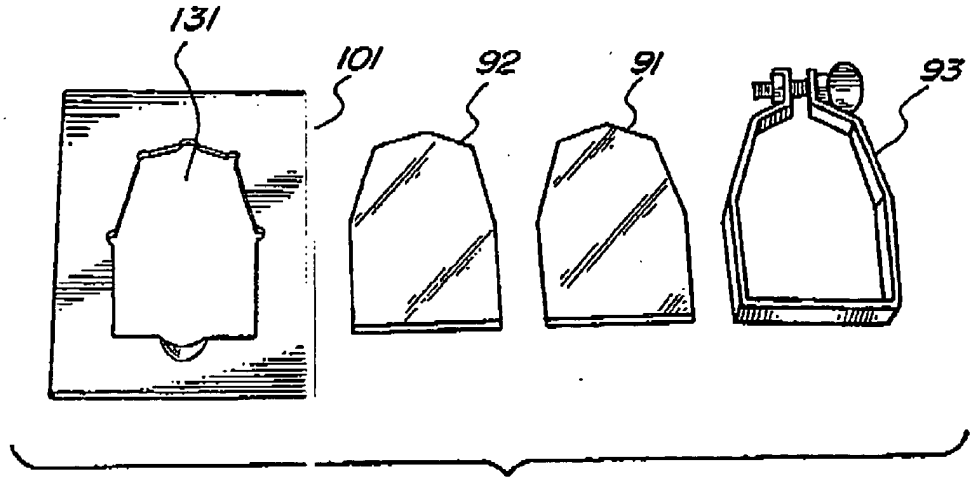


FIG. 16

INTERNATIONAL SEARCH REPORT PCT/US 91/06459

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 A61C9/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	A61C

Documentation Searched other than Minimum Documentation to the extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category[10]	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	DE,A,3 719 039 (TRUMM) 15 December 1988	
A	DE,A,3 837 551 (SCHREIBER) 10 May 1990	
A	DE,A,2 653 743 (SCHWARK) 1 June 1978	

[10] Special categories of cited documents :[11]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
06 DECEMBER 1991	20. 12. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	Vanrunxt J.

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9106459 SA 51531

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 06/12/91
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A-3719039	15-12-88	None	
DE-A-3837551	10-05-90	None	
DE-A-2653743	01-06-78	None	

EPO FORM P0479

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82